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A Study on the Impact of Enterprise Digital Transformation on Business Model Innovation*

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Abstract Taking knowledge management and entrepreneurial orientation as variables, this study explores the impact mechanism and contextual effects of enterprise digital transformation on business model innovation, based on organization reform theory and the knowledge-based view. The findings show that digital transformation has a significant and positive impact on business model innovation, that knowledge management plays an intermediary role in the impact of digital transformation on business model innovation, and that compared to low-level entrepreneurial orientation, high-level entrepreneurial orientation strengthens the relationship between digital transformation and knowledge management, and weakens the relationship between knowledge management and business model innovation.

Keywords digital transformation, business model innovation, knowledge management, entrepreneurial orientation

1 Introduction

The approaches to the promotion of innovation through digital transformation, and responses to the internal and external pressures in the post-pandemic era, are pressing issues for enterprises to achieve high-quality development. As a key driving force in the digital economy era, digital technology is leading industrial transformation, reshaping enterprise production modes, and promoting the emergence and development of new business models. Digital transformation can accelerate the process of business model innovation and provide clear directions for enterprise growth and value creation (Dasilva, 2018). Extant research indicates that from an internal perspective of an enterprise, digital transformation involves profound changes in internal processes (Feng, 2020), integrating R&D, production, marketing, and other activities (Vial, 2019), thus promoting business model innovation. Xiao et al. (2021) point out that applying big data and other digital technologies, the Midea company has transformed from mass manufacturing

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to intelligent manufacturing, providing a new development direction for reshaping business models in traditional manufacturing industry. From an external perspective of an enterprise, digital transformation builds connectivity mechanisms including new platforms, networks, and smart interconnected products, realizing high-level interconnection with customers, partners, and even government departments, and creating a diverse collaborative ecosystem (Autio et al., 2018). Enterprises strengthen external interactions through connectivity technologies, promote resource exchanges such as technology and products, explore future innovation directions in the industry, and achieve cross-domain and cross-regional collaborative innovation (Liu et al., 2021), reshaping business models.

In summary, the impact of digital transformation on business model innovation is complex, but there is currently limited research that delves into the intermediary mechanisms and moderating effects between the two. Based on the knowledge-based view, knowledge acquisition, utilization, and creation are significant drivers of innovation (Zhang et al., 2014) in enterprises. Knowledge management plays a significant role in business model innovation, including the dynamic change process of knowledge application and search (Santoro et al., 2018). Extant research on knowledge management indicates that on the one hand, advanced digital technologies can improve knowledge acquisition and application efficiency, reduce potential loss and distortion during knowledge transfer, enhance knowledge management levels, and promote innovation in knowledge management (Del Giudice et al., 2016). On the other hand, effective application of existing knowledge and search for new knowledge through knowledge management activities can facilitate product and process development, thereby promoting business model innovation (Vrontis et al., 2012). Therefore, knowledge management may be a key intermediary mechanism through which digital transformation influences business model innovation. Additionally, business model innovation is influenced by entrepreneurial orientation. Entrepreneurial orientation, to some extent, can shape an enterprise's understanding of the market, utilize new technologies to provide problem-solving solutions, play an important role in the reconstruction of existing industry ecosystems, adding value, and promoting business model innovation (Zhou et al., 2020). From the perspective of organizational change, digital transformation, as a type of organizational change, is susceptible to the influence of organizational characteristics. Entrepreneurial orientation, as an innovative organizational context, may affect the mechanism through which digital transformation impacts business model innovation. Therefore, this study further explores whether entrepreneurial orientation can moderate the impact mechanism of digital transformation on business model innovation.

2 Theories and Hypotheses

2.1 | Digital Transformation and Business Model Innovation

Currently, most research focuses on the role of digital technology in digital transformation. An (2019) has proposed that the essence of digital transformation lies in applying digital technology to solve complex and uncertain problems, thereby enhancing innovation capabilities and operational efficiency. Vial et al. (2019) propose that digital transformation is a method to achieve significant business improvements through the use of new digital technologies. Singh et al. (2020) further define digital transformation as the strategic arrangement of enterprise digital activities through the application of digital technology. Based on the above viewpoints, this study defines digital transformation as a strategic change in which enterprises apply digital technology to improve business, solve complex and uncertain problems, and enhance innovation capabilities and operational efficiency.

A business model is defined as a description of a system that connects an organization with external stakeholders and creates value for customers and partners through collaboration and through the management of economic activities (Teece, 2010). It includes a series of elements (value proposition, key activities, channels, customer relationships, cost structure, and revenue model, etc.) and their relationships (Osterwalder & Pigneur, 2010). Therefore, business model innovation is considered to be a strategy by which enterprises innovatively establish or adapt value creation and acquisition (Amit & Zott, 2001). This innovation can involve one or more elements and their relationships, as well as the introduction of completely new business models or the fundamental reconstruction of existing business models (Clauss, 2017).

Based on organizational change theory, enterprises stimulate their own innovation vitality during the transformation process. Digital technology becomes a key driving force for business model innovation by creating new organizational structures, cost mechanisms, value exchange mechanisms, and cross-border organizational forms (Feng, 2020). From an internal organizational perspective, digital transformation, to some extent, triggers changes in organizational structure and processes, promotes the generation of new processes and structures that adapt to external environmental changes, and thus achieves business model innovation. Digital transformation requires new organizational forms as carriers, such as more agile and open connection mechanisms (Dasilva, 2018), to promote the generation of ideas and to drive value proposition innovation. Moreover, manufacturing enterprises that introduce digital transformation can optimize production processes, reduce production costs, and improve production efficiency through the timely and effective utilization of data, thereby contributing to business model innovation (Feng, 2020). From an external organizational perspective, enterprises can provide more accurate and high-quality services based on data-driven demand, develop digital

distribution channels, establish new forms of customer participation and customer relationships, move beyond existing markets, or explore untapped business opportunities throughout the entire process of business model innovation (Chi et al., 2020). Enterprises can also promote business model innovation by leveraging digital platforms to access new business opportunities beyond organizational boundaries (Autio et al., 2018). Based on this, this study proposes the following hypotheses.

H1: Digital transformation has a significant and positive impact on business model innovation.

2.2 | Digital Transformation and Knowledge Management

Knowledge is considered to be the root of organizational heterogeneity and an important source of maintaining competitive advantage (Lane et al., 2006). Zhao et al. (2020) define knowledge management as a process through which organizations acquire and absorb external knowledge, and which they transform and apply internal knowledge. Based on previous research, knowledge acquisition and utilization are the most essential stages of knowledge management (Lane et al., 2006). Therefore, this study defines knowledge management as a process of knowledge acquisition and utilization.

Digital transformation plays an important role in the process of knowledge acquisition and application. Firstly, enterprises can directly obtain valuable insights and knowledge from a large amount of existing information or data through digital technology or related equipment (Dasilva, 2018), thereby enhancing their knowledge management capabilities. Technologies such as the internet, big data, and cloud computing can help enterprises quickly understand external market and customer data, explore diverse consumer needs, and provide solutions with higher added value (Vial, 2019). Secondly, digital transformation can positively influence knowledge management, driven by knowledge application (Acharya et al., 2018). By reorganizing and mining valuable information from existing data, enterprises can create a closed-loop system based on the results of big data mining. Such a system allows feedback collection and timely adjustments, optimizes production processes and promotes the application and value realization of information and knowledge. In addition, Teece et al. (2018) point out that digital transformation often requires interaction with external entities such as digital benchmark enterprises and relevant digital transformation service providers to obtain relevant digital resources, thereby continuously improving their own digital capabilities. In this process, the interaction between enterprises and other entities can broaden channels for knowledge transfer and enhance knowledge utilization efficiency. Based on this, this study proposes the following hypothesis.

H2: Digital transformation has a significant positive impact on knowledge management.

2.3 | Knowledge Management and Business Model Innovation

A foundation of business model innovation

is the acquisition and absorption of new knowledge, and effective knowledge management is crucial for enterprise business model innovation (Fjeldstad & Snow, 2018). Enterprises can promote business model innovation through the acquisition of external knowledge and the application of internal knowledge. External knowledge search helps enterprises to obtain information and promote innovation (Guo et al., 2017). Through external knowledge search, enterprises can acquire advanced technology and product knowledge, accelerate R&D processes, and improve product innovation pace. Additionally, external knowledge search can help enterprises to understand comprehensive market information in response to changes in market demands (Wang & Ma, 2018), discover new market opportunities, and provide better services to customers by developing new value propositions, cooperation modes, and transaction processes. Furthermore, the application of internal knowledge is the driving force for enterprises to maintain their innovative growth (Li, 2012). The new knowledge formed by the combination of external and internal knowledge is continuously applied to products or services, such as opening the innovation process to customers, actively involving them in product or service design, production, and delivery processes, reducing knowledge search costs and time, and developing high-quality products and services to enhance competitiveness (Ridge et al., 2017). This can reshape enterprises' market positions, thus supporting business model innovation. Based on this, this study proposes the following hypothesis.

H3: Knowledge management has a significant and positive impact on business model innovation.

2.4 | The Intermediary Role of Knowledge Management

The above analyses show that there is a close relationship between digital transformation, knowledge management, and enterprise business model innovation.

Digital transformation promotes the efficiency of knowledge acquisition and improves the level of knowledge management, thereby achieving business model innovation. Digital transformation can to some extent motivate enterprises to conduct large-scale external information search and acquisition, thereby promoting the improvement of their knowledge management level. When enterprises apply digital technology for knowledge search, they can significantly reduce search costs, transaction costs, and operational costs (Devaraj & Kohli, 2003), and achieve sustainable business innovation.

Digital transformation can promote knowledge application and enable enterprises to adopt business models that are in line with their interests, thus continuously achieving innovation (Ying et al., 2018). The high level of technology applied by enterprises in digital transformation can provide the source of knowledge carriers, create conditions for knowledge transaction and flow sharing and for avoidance of knowledge dispersion and implicitness. This, to some extent, reshapes the knowledge application process (An, 2019), and lays the foundation for the formation of new value propositions

and value capture models. Furthermore, in digital transformation, enterprises can apply technologies such as virtual simulation, digital twins, and visualization, to structure and visualize tacit knowledge, thereby promoting the explicitness of tacit knowledge in production and operation (Lane et al., 2006) and to some extent promoting business model innovation. Based on this, this study proposes the following hypothesis.

H4: Knowledge management plays an intermediary role between digital transformation and business model innovation.

2.5 | The Moderating Effect on Entrepreneurial Orientation

Miller (1983) is the first to propose that entrepreneurial orientation should include three main dimensions: innovativeness, proactiveness, and risk-taking. It was found that entrepreneurial orientation is characterized by innovation, willingness to take risks, and willingness to be the first to introduce new products or services in order to gain a competitive advantage. Based on Miller's viewpoint, this study defines entrepreneurial orientation as a behavioral tendency of enterprises to innovate, take risks, and take action ahead of competitors. In the era of the digital economy, an increasing number of enterprises are experiencing digital transformation and creating new business models and patterns. Under the guidance of high-level entrepreneurial orientation, enterprises are more likely to support the emergence of new paradigms and changes in digital transformation, promoting business model innovation. Furthermore, under the guidance of high-level entrepreneurial orientation, enterprises are more likely to understand external trends and seize opportunities (Yang & Gao, 2020). For example, in the digital economy environment, they can gain insights into the opportunities brought by digital transformation and, in timely manner, adjust their business architecture to achieve business model innovation. In addition, digital transformation itself carries risks, and enterprises with high-level entrepreneurial orientation are more willing to take risks by investing resources in fully testing new technologies, products, services, and even new business processes (Lumpkin & Dess, 1996), thereby innovating their business models. Based on this, this study proposes the following hypothesis.

H5: Entrepreneurial orientation has a positive moderating effect on the relationship between digital transformation and business model innovation.

Entrepreneurial orientation has a positive moderating effect on the relationship between digital transformation and knowledge management. Specifically, if an enterprise has a high level of entrepreneurial orientation, even if it has a low degree of digital transformation, it is willing to engage in a series of innovative activities and invest more in new business combinations that can create value (Lumpkin & Dess, 1996). In this case, knowledge management is likely to become a critical choice for the enterprise as a foundation for promoting value creation. Moreover, under the guidance of high-level entrepreneurial orientation, enterprises, even having no ideas about the costs and returns, have the courage to face

risks and to invest a lot time, effort, thereby managing improvement of their knowledge management. Furthermore, under the guidance of high-level entrepreneurial orientation, enterprises can stay ahead of market trends and seize opportunities (Lechner & Gudmundsson, 2014). As the level of digitalization in enterprises continues to increase, enterprises are likely to enhance their knowledge management capabilities in advance to support their future strategic deployment. Based on this, this study proposes the following hypothesis.

H6: Entrepreneurial orientation has a positive moderating effect on the relationship between digital transformation and knowledge management.

In addition, entrepreneurial orientation can have a moderating effect on the relationship between knowledge management and business model innovation by influencing corporate strategy (Miller, 1983). Firstly, under the guidance of high-level entrepreneurial orientation, enterprises tend to embrace change and innovation. Even if their level of knowledge management is low, advocating a culture of innovation can encourage employees to continuously innovate, thereby promoting business model innovation. Secondly, entrepreneurial orientation to a certain extent enables enterprises to accept various costs and uncertainties in the process of knowledge acquisition and creation (Lechne & Gudmundsson, 2014). If the level of entrepreneurial orientation is low, meaning that the enterprise operates in a low-risk environment and has low levels of knowledge management, the likelihood of business model innovation may not differ from that of earlier practice. However, if the level of knowledge management is high, the knowledge reserves will be richer, which can drive the formation of new methods of value creation and promote business model innovation. Based on this, this study proposes the following hypothesis.

H7: Entrepreneurial orientation has a positive moderating effect on the relationship between knowledge management and business model innovation.

As such, this paper constructs the conceptual model framework as shown in Figure 1.

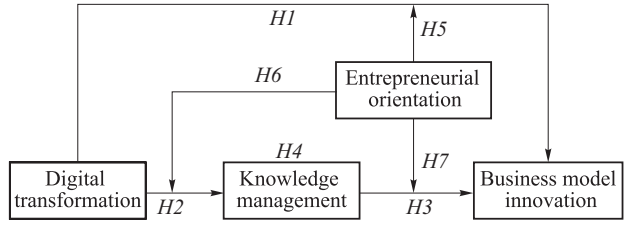

Figure 1 Conceptual Model Framework

3 Research Design

3.1 | Sample and Data Collection

This study collects relevant data through a survey questionnaire, mainly targeting enterprises that have introduced digital transformation. The specific survey targets are senior managers in digitally transformed enterprises, focusing on the Pearl River Delta region in Guangdong Province and Quanzhou City in Fujian Province. To improve the response rate, the questionnaire is distributed using a named enterprise but anonymous respondent approach. To

enhance the objectivity of the survey results, respondents are required to have worked in the enterprise for more than 3 years and have a good understanding of digital transformation, knowledge management, and business model innovation within the enterprise. All questionnaires are distributed and collected by the survey team to avoid potential issues associated with third-party involvement. Additionally, the questionnaire includes reverse measurement items to test the respondents' attitudes, thereby increasing the reliability of the survey. The questionnaires are primarily distributed through two methods.

First, on-site surveys are conducts during entrepreneur symposiums organized by government departments or industry associations. The research team conducts interviews to identify enterprises that have introduced digital transformation, and distributed questionnaires to senior managers on-site.

Second, paper-based questionnaires are distributed to middle and senior managers of enterprises implementing digital transformation and engaged in specialized training courses held by the Department of Industry and Information Technology of Guangdong Province, such as the Smart Manufacturing Development Seminar and High-End Equipment Industry Technology and Management Seminar. The survey period is from March 1 to December 5, 2020.

Using the first method, the research team collects 202 samples. After excluding invalid samples, they obtain 114 valid samples. Using the second method, they collect 183 samples, and after the same screening process, they obtain 106 valid samples. The overall response rate is 57.14%.

To determine whether the response samples collected through the two methods can be combined for analysis, a *T*-test is conducted to determine if these responses samples are significantly different. The description of each variable is provided in Table 1, which shows that there are small differences in mean values, standard deviations, and mean standard error between these response samples distributed and collected differently. The results of the independent questionnaire *T*-test shown in Table 2 indicate that the *F*-values and associated probabilities for variables such as business model innovation, knowledge management, digital transformation, and entrepreneurial orientation are all greater than the significance level of 0.05. This suggests that there are no significant differences in the variances of the variables between these two groups of response samples. The probability associated with the *T*-value for equal variances is also greater than the significance level of 0.05, indicating that there is no significant difference in the response samples collected through the two methods. Therefore, these samples can be combined for analysis.

The specific sample characteristics are as follows. In terms of enterprise size, large-and medium-sized enterprises account for 62.6%, while small- and micro-sized enterprises account for 37.4%. In terms of the establishment age of the enterprises, those with less than 3 years account for 3.0%, 3–6 years account for 25.9%, 6–10 years account for 31.7%, and those with more than 10 years account for 39.4%. In terms

Table 1 Descriptive Statistical Results of Variables under the Two Survey Methods

Variable	Survey method	Sample number	Mean	Standard deviation	Mean standard error
Business model innovation	1	114	5.385	1.188	0.111
	2	106	5.411	1.106	0.107
Knowledge management	1	114	5.084	1.325	0.124
	2	106	5.190	1.128	0.110
Digital transformation	1	114	4.993	1.485	0.139
	2	106	4.915	1.468	0.143
Entrepreneurial orientation	1	114	4.990	1.033	0.097
	2	106	5.091	1.029	0.100

Note. "1" represents the data collected by the research team during on-site surveys or entrepreneur symposiums organized by government departments or industry associations. "2" represents the data collected during specialized training courses held by the Department of Industry and Information Technology of Guangdong Province, such as the Smart Manufacturing Development Seminar and High-End Equipment Industry Technology and Management Seminar.

Table 2 *T*-test Results of Two Independent Samples

Variable	*F*-value	*F*-value associated probability	*T*-value	*T*-value associated probability with equal variance
Business model innovation	0.001	0.970	−0.167	0.867
Knowledge management	1.471	0.227	−0.633	0.527
Digital transformation	0.014	0.905	0.391	0.696
Entrepreneurial orientation	0.658	0.418	−0.727	0.468

of the distribution of enterprise ownership, state-owned enterprises account for 25.2%, private enterprises account for 47.0%, and others account for 27.8%. In terms of enterprise revenue, enterprises with 20 million yuan or below account for 8.6%, those with 20 million to 100 million yuan account for 14.5%, those with 100 million to 400 million yuan account for 30.1%, those with 100 million to 1 billion yuan account for 27.4%, and those with over 10 billion yuan account for 19.4%. Overall, the valid samples received cover enterprises of different sizes, ages, and ownership types, indicating that the sample range in this study meets the research requirements.

3.2 | Variable Measurement

The measurement of research variables is based on mature scales from domestic and international sources. The specific sources of variable measurement items are as follows. For the measurement of digital transformation variables, we draw on

the research findings of Chi et al. (2020) to reflect the extent to which enterprises apply digital technology for transformation and business improvement. Three items are used for measurement. For the measurement of business model innovation variables, we refer to the research findings of Osterwalder and Pigneur (2010), mainly measuring business model innovation from the perspective of business model elements, including value proposition, customer segmentation, channel pathways, customer relationships, core resources, key activities, important partners, cost structure, and revenue model. Nine dimensions are measured using nine items. For the measurement of knowledge management variables, we draw on the research findings of Lane et al. (2006), measuring knowledge management from the perspectives of knowledge acquisition and utilization, with six items. For the measurement of entrepreneurial orientation variables, we refer to the research findings of Lumpkin and Dess (1996). The measurement focuses on dimensions such as innovativeness, proactiveness, and risk-taking. Based on pre-survey results, four items are finally determined. All the items mentioned above are designed using a Likert 7-point scale, where 1 represents "strongly disagree" and 7 represents "strongly agree." The specific questionnaire items can be found in Table 3.

Table 3 Dimension Items and Standardization Factor Loads (*N*=220)

Variable	Measurement item	Load
DT	Over the past 3 years, we have been operating business processes based on digital technologies	0.948
	Over the past 3 years, we have been integrating digital technologies to transform our business processes	0.949
	Over the past 3 years, our business operations have been shifting toward application of digital technologies	0.923
BMI	Over the past 3 years, we have developed new products or services	0.854
	Over the past 3 years, we have identified and served new markets and customer groups	0.853
	Over the past 3 years, we have developed and/or acquired new resources and capabilities (technology, personnel, IT systems, etc.)	0.870
	Over the past 3 years, we have developed new core processes and activities (design, production, logistics, marketing, etc.)	0.878
	Over the past 3 years, we have established new strategic business partnerships	0.819
	Over the past 3 years, we have developed new customer relationships	0.842
	Over the past 3 years, we have sold products and/or services through new channels	0.732

(*To be continued*)

(*Continued*)

Variable	Measurement item	Load
	Over the past 3 years, we have made significant changes to our cost structure	0.758
	Over the past 3 years, we have developed new sources of revenue (products, services, leasing, investments, etc.)	0.859
KM	The enterprise often acquires technology from external channels	0.898
	The enterprise regularly holds dedicated meetings with external partner organizations to acquire technology	0.907
	The enterprise frequently engages with external entities to gain technological knowledge	0.879
	The enterprise is proficient in leveraging existing knowledge for new purposes	0.885
	The enterprise is capable of quickly analyzing and interpreting market changes for technological needs	0.907
	The enterprise can swiftly identify opportunities to serve customers using existing technologies	0.905
EO	In the face of uncertainty, the enterprise often adopts a proactive approach	0.826
	Managers actively respond to competitors by adopting new methods	0.858
	The enterprise is willing to try new approaches and solutions	0.906
	The enterprise encourages employees to adopt new ways of doing things for management innovation, thereby facilitating the achievement of organizational goals	0.852

Note. *DT*=digital transformation; *BMI*=business model innovation; *KM*=knowledge management; *EO*=entrepreneurial orientation.

In addition, this study selects enterprise age, enterprise size, enterprise revenue, and property rights as control variables. Following the research findings of Yu et al. (2020), enterprise age is categorized into four groups: less than 3 years, 3–6 years, 6–10 years, and over 10 years. Enterprise size is set as a dummy variable, with 1 representing large and medium-sized enterprises and 0 representing small and micro-sized enterprises. Property rights are divided into three categories: state-owned enterprises, private enterprises, and others, and two dummy variables are set accordingly. To present the results more clearly, this study only reports the measurement results of one dummy variable each for enterprise size and property rights.

3.3 | Analysis Method

This study uses partial least squares (PLS) for data analysis, using the software Smart PLS 3.0. The choice of PLS for estimation in this study is for the following reasons. Firstly, a requirement is to explore whether and how digital transformation enhances business model innovation in enterprises. The relevant research in this field is currently in the qualitative exploration stage, and PLS can maximize the explanatory power of the dependent variable, making it suitable for this study (Hair et al., 2016). Secondly, the research model in this study explores the moderating effect of entrepreneurial orientation as a latent variable, and PLS is suitable for analyzing the moderating effect

of latent variables (Liu et al., 2016). Thirdly, PLS has lower requirements for sample size and statistical distribution, making it suitable for small sample estimation and applicable to this study.

4 Empirical Analysis

Following the two-step approach proposed by Anderson and Gerbing (1988), this study first reports the results of the measurement model (outer model) analysis and then reports the results of the structural model data analysis (inner model).

4.1 | Measurement Model

4.1.1 *Reliability and Validity Analysis*

The measurement model primarily assesses data reliability, convergent validity, and discriminant validity. Firstly, according to Hair et al. (2016), the standardization factor loads of the items should be greater than 0.707. From Table 3, it can be seen that all standardization factor loads in this study meet the standard. Secondly, this study uses Cronbach's alpha to test the construct reliability. As shown in Table 4, the reliability of all four constructs is above 0.9, and the composite reliability (CR) is also above 0.9, indicating good reliability of the constructs. The average variance extracted (AVE) values for the constructs in Table 4 are all above 0.646, greater than 0.5, indicating good convergent validity of the data. For discriminant validity, the square root of the AVE values on the diagonal (see Table 4) is greater than the correlation coefficients between the constructs, indicating good discriminant validity. In addition, this study uses the Heterotrait-Monotrait (HTMT) test to examine discriminant validity, as shown in Table 5. It can be seen from Table 5 that all values are below the recommended threshold of 0.85, further indicating good discriminant validity of the data.

4.1.2 *Common Method Variance Test*

Two methods, pre-procedural control and post-statistical testing, are used to reduce common method bias (Yu et al., 2020). Regarding pre-procedural control, the research purpose is not disclosed during the questionnaire survey to control potential expectation effects from respondents. Moreover, the questionnaire items are randomly arranged to prevent response bias due to the similarity of items. Additionally, reverse items are designed to test respondents' attitude toward answering. Furthermore, anonymity of the survey is promised in the questionnaire instructions to protect the privacy of the respondents. For post-statistical testing, the practice of Liang et al. (2007) is followed, and a common method bias factor is added to the confirmatory factor analysis. The results show that the average variance explained by the original constructs is 0.714, while the average variance explained by the common method bias factor is 0.005. The ratio between the two is 143 ∶ 1, and most of the paths influenced by the common method bias factor are not significant, further demonstrating that the impact of common method bias in this study is minimal. Moreover, the Harman's single-factor test results show that the proportion of variance explained by the first unrotated

Table 4 Reliability and Validity Analysis Results (*N*=220)

Variable	1	2	3	4	Cronbach's α	CR	AVE
1.*BMI*	**0.831**				0.943	0.952	0.690
2.*DT*	0.642	**0.940**			0.935	0.958	0.884
3.*EO*	0.631	0.492	**0.804**		0.855	0.898	0.646
4.*KM*	0.556	0.557	0.514	**0.895**	0.959	0.966	0.801

Note. Diagonal bold characters are the root sign value of AVE; the lower triangle is Pearson correlation coefficient; *BMI* stands for business model innovation, *DT* stands for digital transformation, *EO* stands for entrepreneur orientation and *KM* stands for knowledge management.

Table 5 Heterotrait-Monotrait Test Results (*N*=220)

Variable	1	2	3	4
1.*BMI*				
2.*DT*	0.680			
3.*EO*	0.695	0.551		
4.*KM*	0.588	0.583	0.578	

factor is less than 50%, indicating that the influence of common method bias is within an acceptable range. The above analyses validate the reliability of the data and provides a basis for statistical inference in the following sections.

4.2 | Structural Model

4.2.1 *Testing of Direct and Intermediary Effects*

Figure 2 shows that after controlling for variables such as enterprise size, nature, establishment years, and revenue, the coefficient of digital transformation impact on business model innovation is 0.335, with a *p*-value less than 0.001 and a 95% confidence interval for the bias-corrected estimates of (0.188, 0.480), excluding zero. This indicates a positive correlation between digital transformation and business model innovation, providing empirical support for *H1*. The regression coefficient of digital transformation impact on knowledge management is 0.557, with a *p*-value less than 0.001 and a 95% confidence interval of (0.444, 0.635), excluding zero. This suggests a positive correlation between digital transformation and knowledge management, supporting *H2*. The regression coefficient of knowledge management impact on business model innovation is 0.162, with a *p*-value less than 0.05 and a confidence interval of (0.017, 0.303), excluding zero. This indicates a positive correlation between knowledge management and business model innovation, supporting *H3*. Furthermore, the model's explanatory power for the dependent variable of business model innovation is 0.584, which, according to the recommended standards (Hair et al., 2016), demonstrates that the model of how digital transformation directly or indirectly influences business model innovation through knowledge management has a relatively high explanatory power. The explanatory power of digital transformation

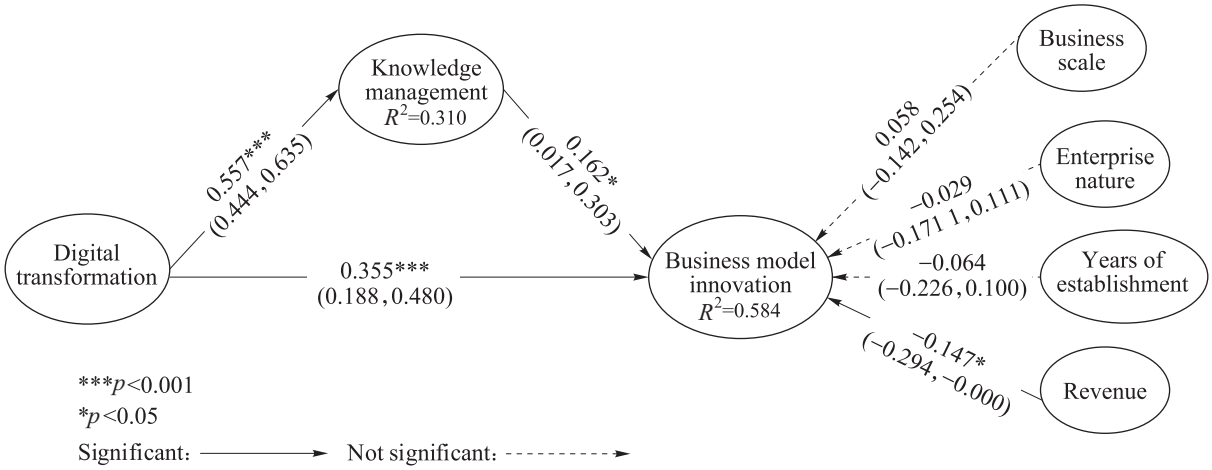

Figure 2 Intermediary Function Analysis

on knowledge management is 0.310, which falls within the moderate range.

For testing the intermediary effect, the traditional method is Baron & Kenny's three-step test. However, being frail, this method is gradually being replaced by Bootstrap. In this study, both the traditional three-step test and the Sobel test are used for verification. Figure 2 indicates that the independent variable of digital transformation of enterprises has a significant impact on the dependent variable of business model innovation. It also shows that the independent variable of digital transformation of enterprises has a significant impact on the intermediary variable of knowledge management. In addition, when integrating the intermediary variable of knowledge management in the analysis, a significant relationship between the intermediary variable and the dependent variable is found. The results of the Sobel test (Sobel Z = 3.245, p < 0.01) indicate that the mediation effect of knowledge management is established. This study uses the Bootstrap method to verify the robustness of the mediation effect through repeated sampling. The results of 5,000 Bootstrap samples show that the mediation effect of knowledge management on the relationship between digital transformation of enterprises and business model innovation is 0.090, with a p-value less than 0.05 and a confidence interval of (0.017, 0.190), excluding zero (see Table 6). Therefore, based on the three methods mentioned above, this study concludes that knowledge management has the mediation effect in the relationship between enterprise

Table 6 Mediation Test Results (N=200)

Path	Coefficient	Standard error	T-value	p-value	Bootstrap 5000 deviation correction interval	
					2.50%	97.50%
Enterprise digital transformation ——►Knowledge management ——►Business model innovation	0.090	0.044	2.052	0.040	0.017	0.190

digital transformation and business model innovation, supporting *H4*.

4.2.2 *Testing of Latent Variable Moderating Effect*

The analysis of the moderating effect of entrepreneurial orientation as a latent variable is presented in Figure 3. Following the research methodology of Oduro and Haylemariam (2019), this study constructs the interaction term using a product approach. The regression coefficient of the interaction term between entrepreneurial orientation and digital transformation on business model innovation is 0.087 ($p > 0.05$), with a confidence interval of (−0.054, 0.209), which includes zero. This suggests that the moderating effect of entrepreneurial orientation on the relationship between digital transformation and business model innovation is not significant, so that *H5* is not supported by the empirical data. This could be due to the fact that achieving digital transformation solely through the efforts of the enterprise itself is unrealistic, and it requires the integration of multiple resources to achieve the desired outcomes . For example, enterprises may need to collaborate with various stakeholders through digital platforms to reshape their business models and create value beyond existing products and services. However, this may also weaken the role of enterprise-specific contextual factors, resulting in a lack of empirical support for the moderating effect of entrepreneurial orientation on the relationship between digital transformation and business model innovation.

Furthermore, the regression coefficient of the interaction term between entrepreneurial orientation and digital transformation on knowledge management is 0.100 ($p < 0.05$), with a confidence interval of (0.046, 0.143), which does not include zero. This indicates that entrepreneurial orientation has a significant moderating effect on the relationship between digital transformation and knowledge management, supporting *H6*. The regression coefficient of the interaction term between entrepreneurial orientation and knowledge management on business model innovation is −0.147 ($p < 0.05$), with a confidence interval of (−0.276, −0.066), which does not include zero. This suggests that entrepreneurial orientation moderates the relationship between knowledge management and business model innovation. However, this finding is not fully consistent with *H7*, as it only partially supports the hypothesis.

To further explore the moderating effect of entrepreneurial orientation on the relationships between digital transformation and knowledge management, as well as between knowledge management and business model innovation, this study conducted a simple slope analysis by plotting the interaction effect (see Figure 4). Figure 4 shows that in the case of high-level entrepreneurial orientation, the relationship between digital transformation and knowledge management is more significant (larger slope), indicating that with high-level entrepreneurial orientation, digital transformation can better promote knowledge management, further supporting *H6*. Figure 4 also shows that

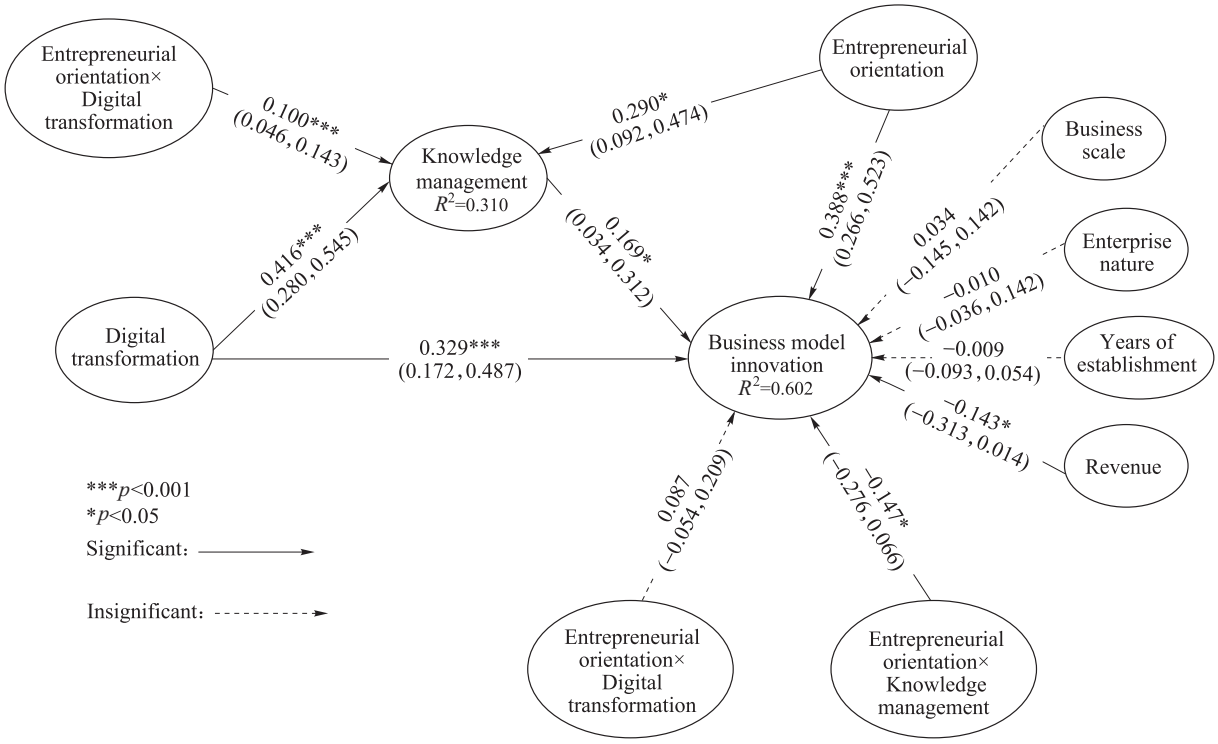

Figure 3 Moderating Effect of Entrepreneurial Orientation (*N*=220)

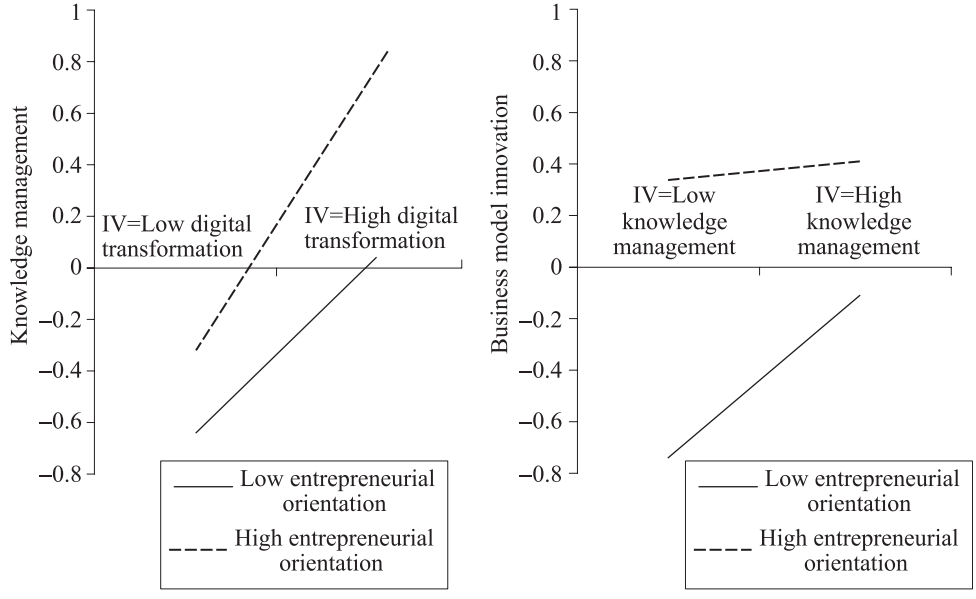

Figure 4 Simple Slope Analysis of Entrepreneurial Orientation

with high-level entrepreneurial orientation, the slope of the relationship between knowledge management and business model innovation is smaller. Where levels of entrepreneurial orientation are low, the slope of the relationship between knowledge management and business model innovation is larger, suggesting that high-level entrepreneurial orientation may inhibit the positive effect of knowledge management on business model innovation, which is inconsistent with *H7* and therefore *H7* is not fully supported.

5 Conclusions

5.1 | Research Conclusions

This study explores the mechanism through which digital transformation influences business model innovation and offers the following main conclusions.

Digital transformation has a significant positive impact on business model innovation. This conclusion indicates that digital transformation provides unlimited driving force for business model innovation, which is consistent with the mainstream view (Feng, 2020) that in the context of the digital economy, digital transformation is crucial for enterprises to adapt to external environmental changes and maintain their competitive advantages.

Knowledge management has a mediation effect on the relationship between digital transformation and business model innovation. This conclusion enriches and expands extant research. This study not only reveals the antecedent variable of digital transformation that drives the development of knowledge management in enterprises but also supports the view that knowledge management promotes business model innovation, and establishes the link between the three, revealing the intermediary role of knowledge management. The conclusion suggests that digital transformation, through comprehensive transformation of enterprises, enhances the level of knowledge management. Based on the knowledge-based view, enterprises can streamline their internal complex knowledge as part of the process of knowledge management, while also expanding their boundaries to a large extent, thereby enhancing the possibility of business model innovation.

Entrepreneurial orientation positively moderates the relationship between digital transformation and knowledge management, indicating that under the guidance of high-level entrepreneurial orientation, as enterprises progress in their digital transformation journey, their level of knowledge management continues to improve. This conclusion affirms the importance of entrepreneurial orientation in strategic decision-making and strategy selection in enterprises. Specifically, entrepreneurial orientation plays a crucial role in the process of enterprise transformation and innovation. High-level entrepreneurial orientation provides a foundation for enterprises' digital transformation and can strengthen the relationship between

the two. However, compared to low levels of entrepreneurial orientation, high-level entrepreneurial orientation weakens the relationship between knowledge management and business model innovation. It is generally believed that knowledge management is an important driving force (Fjeldstad & Snow, 2018) for business model innovation (Yan et al., 2019). Under the guidance of high-level entrepreneurial orientation, enterprises are more forward-looking and tend to invest resources in the process of knowledge management, influencing knowledge acquisition, innovation, and utilization, thus driving business model innovation. This conclusion is inconsistent with extant research findings, and the main reason may be that entrepreneurial orientation is an important driver of business model innovation in enterprises. Under the guidance of high-level entrepreneurial orientation, enterprises tend to create an innovative atmosphere, thereby improving the efficiency of business model innovation (Klein et al., 2022; Yan et al., 2019). Therefore, under the guidance of high-level entrepreneurial orientation, enterprises can independently achieve business model innovation and reduce their reliance on knowledge management, thus inhibiting the role of knowledge management in business model innovation. Under the guidance of low levels of entrepreneurial orientation, business model innovation is more likely to be positively influenced by knowledge management, and as the level of knowledge management continues to improve, the level of business model innovation also increases.

5.2 | Theoretical Contributions

This study integrates organizational change theory and knowledge-based theory to clarify the role of digital transformation in business model innovation, providing a new theoretical perspective on how digital transformation impacts business model innovation in enterprises.

This study reveals the key pathway of digital-driven business model innovation, emphasizing the promotion of business model innovation through enhancing knowledge management capabilities. Knowledge management plays an important role in digital transformation enterprises and can help enterprises to overcome existing technological bottlenecks, create new value, and promote business model transformation. The study introduces knowledge management theory into the research on business model innovation pathways, enriching the understanding of the evolutionary mechanism of business model innovation in digital transformation enterprises.

This study introduces the variable of entrepreneurial orientation and explores its contextual effects on business model innovation in enterprises' digital transformation, filling gaps in extant research.

5.3 | Management Implications

Chinese enterprises should actively promote their own digital transformation and accelerate digital application.

Developing the digital economy is a shared opportunity and consensus existing among countries worldwide. Accelerating digital transformation is of great significance for enterprises. Chinese enterprises should seek digital transformation approaches that suit their strategic requirements, discovering and creating more knowledge through digital transformation, finding new value creation points, and achieving business model innovation and transformation.

Chinese enterprises should recognize the importance of knowledge management and enhance their knowledge management capability. In the era of the digital economy, the knowledge management system combines knowledge acquisition, storage, search, and integration of intellectual resources with core business processes, thereby adding value to knowledge in the innovation process and building unique market competitiveness for enterprises. Therefore, enterprises should invest more resources in enhancing their knowledge management capability, fully leveraging the role of knowledge management in the digital age, and improving their innovation capability.

Currently, the authors recommend that Chinese enterprises drive their own transformation with a new perspective and a firm attitude. They should adopt an open mindset, forward-thinking strategic thinking ability, and a willingness to take risks to determine the approach and direction of digital transformation. They should actively promote their enterprise knowledge system, improve their learning and innovation capability, and embrace the digital age with a more positive attitude.

5.4 | Limitations and Future Outlook

Quantitative research on digital transformation is still in its early stages. This study explores the impact mechanism of digital transformation on business model innovation from the perspective of knowledge management. However, there are other complex mechanisms that need to be studied. Future research can further explore the impact mechanism from different perspectives and reveal the influence path of digital transformation on business model innovation. Furthermore, the empirical analysis results in this study (showing that entrepreneur orientation weakens the relationship between knowledge management and business model innovation) are inconsistent with previous theoretical analysis results. Although this study provides some tentative explanations, it is difficult to determine the relationship of moderating effect solely based on one empirical study. Further research is needed to explore this relationship. Finally, due to regional restrictions, the samples in this study are mainly concentrated in the southeast of China. In the future, the geographical representativeness of samples can be expanded to improve the robustness of research conclusions.

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